VERIFICATION OF TRANSLATION

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I state that the following is an accurate translation of

Japan Patent Application No. H10-341129 to the best of my knowledge and belief.

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TITLE OF THE INVENTION

Recording/Reproduction Head Support Mechanism and Recording/Reproduction Apparatus

BACKGROUND OF THE INVENTION

Field of the Invention:

[0001]

This invention relates to a recording/reproduction-head-support mechanism in a recording/reproduction apparatus such as a hard disc drive (abbreviated to HDD below), optical disc drive or the like, and to a recording/reproduction apparatus comprising this recording/reproduction-head-support mechanism.

Description of the Related Art:

[0002]

A conventional magnetic-head-support mechanism that is used in a HDD supports a slider, in which an electromagnetic-conversion element is installed, by way of a suspension, and typically has a wiring pattern that connects to the electromagnetic-conversion element.

[0003]

The electromagnetic-conversion element has in addition to magnetic poles and a coil for mutually converting electric signals and electromagnetic signals, a magneto-resistance effect element for converting electromagnetic signals to voltage signals, and these are formed using thin-film formation technology, assembly-processing technology or the like. The slider is constructed from a magnetic body such as a non-ceramic like Al_2O_3-TiC or $CaTiO_3$, or ferrite, and the shape is mainly a rectangular shape, with the surface that faces the disc medium (air-bearing surface) processed into a suitable shape for generating

pressure so that it floats a minute distance above the disc medium. The suspension that supports the slider is formed by performing a process such as bending or punching of a material having elasticity such as stainless steel plate or the like.

[0004]

During actual use, static electricity may be generated inside the slider. This static electricity is generated by friction due to back-and-forth motion between the slider's floating surface and the disc medium surface during contact-start-stop (CSS), contact between the slider's floating surface and the disc medium surface that occurs when the amount that the slider floats above the disc medium surface when rotating at high speed is extremely small, friction between the slider and air, or the like.

[0005]

When static electricity occurs in the slider, a phenomenon of electrostatic damage may occur in the electromagnetic-conversion element. In order to prevent this, in many magnetic heads the slider is grounded (for example, refer to Japanese patent publication H2-61810, H2-244419, H8-111015). In the aforementioned Japanese patent publication H2-61810, a thin-film magnetic head is disclosed in which an electrical conductor that is electrically connected to a magnetic core located in the slider is attached using conductive adhesive to the gimbal section of the suspension which is at earth potential. Also, as disclosed in the aforementioned Japanese patent publication H2-244419, the side surface of the slider is attached to the suspension with a conductive adhesive. Moreover, in the aforementioned Japanese patent publication H8-111015, a magnetic head apparatus is disclosed in which there is a ground electrode located on a flexible wiring substrate that is located on the suspension, and this ground electrode is electrically connected to the slider.

[0006]

However, as HDD have become more compact and recording is performed at higher density, the track density has increased and thus the track width has become narrower. In order to improve the tracking precision of a high-density recording HDD, it is effective to install an actuator in the magnetic head that moves the electromagnetic-conversion element or slider a minute amount with respect to the suspension. This kind of actuator has been disclosed for example in Japanese patent publications H6-259905, H6-309822 and H8-180623.

[0007]

[Problems to be Solved By the Invention]

In a magnetic head that has an actuator, the actuator is located between the suspension and the electromagnetic-conversion element, so the wiring that connects the suspension side with the electromagnetic-conversion element must go over or around the actuator. When the actuator drives the slider, the slider moves relative to the suspension, so the electric wiring that connects the suspension side and the slider side could obstruct this movement.

[0008]

However, the aforementioned disclosure that describes the installation of an actuator, does not mention anything regarding the grounding of the slider. Therefore, naturally, when an actuator is interposed, no means are disclosed for grounding the slider such that the movement performance of the actuator is not obstructed.

SUMMARY OF THE INVENTION

[0009]

The object of this invention is to prevent electrostatic damage of an electromagnetic-conversion element or optical module in the recording/reproduction-head-support mechanism of a magnetic disc

apparatus or optical disc module having an actuator for minute movement without obstructing the movement performance of the actuator.

[0010]

This objective is accomplished by the following invention:

(1) A recording/reproduction-head-support mechanism comprising:

a slider, in which an electromagnetic-conversion element or optical module is installed, and a suspension; wherein

the slider is supported by the suspension by way of an actuator for moving the slider; and

a grounding area on the suspension is electrically connected to the slider by an electrical-connection member that is capable of moving and/or deforming in the direction that the actuator moves the slider.

(2) The recording/reproduction-head-support mechanism of (1) above wherein the suspension is constructed from electrically conductive material, and the suspension itself is used as said grounding area.

(3) The recording/reproduction-head-support mechanism of (1) above wherein a grounding electrode is formed on the surface of the suspension as said grounding area.

(4) A recording/reproduction-head-support mechanism comprising:

a slider, in which an electromagnetic-conversion element or optical module is installed, and a suspension; wherein

the slider is supported by the suspension by way of an actuator for moving the slider; and

an electrically conductive area is formed on at least part of the actuator, and a grounding area on the suspension is electrically connected to the slider by way of this electrically conductive area.

(5) A recording/reproduction-head-support mechanism comprising:

a slider, in which an electromagnetic-conversion element or optical module is installed, and a suspension; wherein

the slider is supported by the suspension by way of an actuator for moving the slider; and

a wiring pattern, which includes wiring that electrically connects to the electromagnetic-conversion element or optical module, and a grounding conductor that electrically connects to the slider, is capable of moving and/or deforming in the direction that the actuator moves the slider, and extends from the surface of the suspension over the actuator to the slider.

(6) A recording/reproduction-head-support mechanism comprising:

a slider, in which an electromagnetic-conversion element or optical module is installed, and a suspension; wherein

the slider is supported by the suspension by way of an actuator for moving the slider;

a wiring pattern, which includes wiring that electrically connects to the electromagnetic-conversion element or optical module, and a grounding conductor that electrically connects to the slider, adheres to and is formed on the surface of the suspension; and

the tip-end section of the suspension curves or bends over the actuator toward the slider, and at least part of said tip-end section is capable of moving and/or deforming in the direction that the actuator moves the slider.

(7) A recording/reproduction apparatus comprising the recording/reproduction-head-support mechanism of any one of the (1) to (6) above.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an example of the construction of the magnetic head of a first embodiment of the invention, and it is a side view showing the state

in which the slider is attached to the suspension by way of an actuator.

Fig. 2 shows another example of the construction of the magnetic head of the first embodiment of the invention, and it is a plan view showing the state in which the slider is attached to the surface of the suspension that faces the medium by way of an actuator.

Fig. 3 shows an example of the construction of the magnetic head of a second embodiment of the invention, and it is a side view showing the state in which the slider is attached to the suspension by way of an actuator.

Fig. 4 shows another example of the construction of the magnetic head of the second embodiment of the invention, and it is a side view showing the state in which the slider is attached to the suspension by way of an actuator.

Fig. 5 shows an example of the construction of the magnetic head of a third embodiment of the invention, and it is a plan view showing the state in which the slider is attached to the surface of the suspension that faces the medium by way of an actuator.

Fig. 6 shows another example of the construction of the magnetic head of the third embodiment of the invention, and it is a plan view showing the state in which the slider is attached to the surface of the suspension that faces the medium by way of an actuator.

Fig. 7 shows another example of the construction of the magnetic head of the third embodiment of the invention, and it is a plan view showing the state in which the slider is attached to the surface of the suspension that faces the medium by way of an actuator.

Fig. 8 is an isometric exploded view showing an example of the construction of a magnetic head-support mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011]

The recording/reproduction-head-support mechanism of this invention comprises a slider, in which an electromagnetic-conversion element or

optical module is installed, and a suspension; and the slider is supported by the suspension by way of an actuator that moves the slider. Below, an example of applying the present invention to a magnetic head having a slider in which an electromagnetic-conversion element is installed will be explained.

[0012]

First, the typical construction of a suspension, actuator and slider will be explained.

[0013]

Fig. 8 is an isometric exploded view showing an example of the construction of a magnetic head-support mechanism having an actuator. This magnetic head-support mechanism comprises: a slider 2 in which an electromagnetic-conversion element 1 is installed, a suspension 3 that supports this slider 2, and an actuator 4 that is located between the slider 2 and the suspension 3.

[0014]

The actuator 4 is for moving the slider 2 a minute amount with respect to the suspension 3, and it is fastened using adhesive or the like to the gimbal section 3a located at the base-end section of the suspension 3. The gimbal section 3a is formed by creating grooves by etching, punching or the like for the purpose of having the slider follow the disc medium surface. A main actuator (VCM, etc.) for driving the entire suspension is installed in this magnetic head.

[0015]

The actuator 4 comprises a stationary section 43, a movable section 44, and two rod-shaped movement-generation sections 41, 41 that connect the stationary section 43 and movable section 44. On the movement-generation section 41 there is at least one

piezoelectric-electrostriction material layer on which there is an electrode layer on both ends; and construction is such that by applying voltage to the electrode layers, expansion and contraction occurs. The piezoelectric-electrostriction material layer is made from piezoelectric-electrostriction material that expands or contracts due to the reverse piezoelectric effect or electrostriction effect. Construction is such that one end of the movement-generation section 41 is connected to the suspension by way of the stationary section 43, and the other end of the movement-generation section 41 is connected to the slider by way of the movable section 44, and the slider moves due to the expansion and contraction or the movement-generation section 41, and moves in an arc shape such that the electromagnetic-conversion element crosses the recording tracks on the disc medium.

[0016]

In the actuator 4, when the piezoelectric-electrostriction material layer on the movement-generation section 41 is made of so-called piezoelectric material such as PZT, polarization processing of the piezoelectric-electrostriction material layer is normally performed in order to improve the movement performance. The polarization direction due to this polarization processing is the direction of thickness of the actuator. When the orientation of the electric field that occurs when voltage is applied to the electrode layer coincides with the polarization direction, the piezoelectric-electrostriction material layer between both electrodes expands in that thickness direction (vertical piezoelectric effect), and contracts in that planar direction (horizontal piezoelectric effect). On the other hand, when the orientation of the electric field is opposite the direction of polarization, the piezoelectric-electrostriction material layer contracts in the thickness direction (vertical piezoelectric effect) and expands in the planar direction (horizontal piezoelectric effect). Also, by alternately applying voltage that causes expansion and contraction to one of the

movement-generation sections and the other movement-generation section, the ratio of the length of the one movement-generation section changes with respect to the length of the other movement-generation section, and due to this change, both movement-generation sections bend in the same direction in the plane of the actuator. This bending causes the movable section 44 to move back-and-forth with respect to the stationary section 43 in the direction of the arrows shown in the figure, with the position when no voltage is applied as the center of movement. This back-and-forth movement is a movement in which the movable section 44 follows an arc-shaped path in a direction that is nearly orthogonal to the direction of expansion and contraction of the movement-generation sections 41, and the direction of the back-and-forth movement is in the plane of the actuator. Therefore, the electromagnetic-conversion element also follows an arc-shaped path in a back-and-forth motion. At this time, since the direction of the voltage and polarization is the same, there is no problem of polarization damping, and is desirable. The same kind of back-and-forth movement occurs even when the voltage applied alternately to both of the movement-generation section causes the movement-generation sections to expand.

[0017]

In the actuator shown in the figure, it is also possible to simultaneously apply a voltage to both movement-generation sections that will cause both to move in the opposite direction. In other words, it is possible to simultaneously apply alternating voltage to one of the movement-generation sections and the other movement-generation section so that when the one expands the other contracts, and when the one contracts the other expands. The back-and-forth movement of the movable section 44 at this time is such that the position when no voltage is applied is the center of movement. In this case, the amplitude of the back-and-forth movement when the drive voltage is made to be the same is approximately twice that of when voltage is applied alternately. However, in this case, on one side of the back-and-forth movement, the movement-generation unit

is caused to expand, and when this happens the drive voltage becomes opposite that of the polarization. Therefore, when the applied voltage is high, or when voltage is applied intermittently, there is a possibility that the polarization of the piezoelectric-electrostriction material will be damped. By applying a direct-current bias voltage in the same direction as the polarization, and making the result obtained by overlapping the aforementioned alternating voltage on to this bias voltage the drive voltage, the direction of the drive voltage does not become the opposite direction of the polarization. The back-and-forth movement in this case is such that the position when only the bias voltage is applied becomes the center of movement.

[0018]

The actuator shown in the figure is constructed such that the movement-generation sections 41, stationary section 43 and movable section 44 are formed into one member by forming holes and notches in the plate-shaped body of the piezoelectric-electrostriction material on which electrode layers are formed in specified locations. Therefore, it is possible to increase the rigidity and precision of dimensions of the actuator without the problem of assembly errors. Also, since no adhesive is used in the manufacture of the actuator, there is no adhesive layer in the section where stress occurs due to deformation of the movement-generation sections. Therefore, there are no problems of transmission loss due to an adhesive layer, or change over time of the adhesive strength.

[0019]

The piezoelectric-electrostriction material in this invention means material that expands or contracts due to inverse piezoelectric effect or electrostriction effect. The piezoelectric-electrostriction material can be any material as long as it is suitable material for the movement-generation sections of the kind of actuator described above,

however, since the rigidity is high, normally a ceramic piezoelectric-electrostriction material such as PZT [Pb(Zr, Ti)O_3], PT ($PbTiO_3$), PLZT [(Pb, La)(Zr, Ti)O_3], or barium titanate ($BaTiO_3$) is preferred. In the case where the actuator is made of ceramic piezoelectric-electrostriction material, it can be easily manufactured using a thick-film method such as a sheet method or printing method. The actuator can also be manufactured using a thin-film method. In the case where the piezoelectric-electrostriction material has a crystal structure, a polycrystalline substance or a single-crystalline substance can be used.

[0020]

The method for forming the electrode layers is not particularly limited, and taking into consideration the method for forming the piezoelectric-electrostriction material layer, can be suitably selected from among various methods such as printing of electrically conductive paste, firing, sputtering, vapor deposition or the like.

[0021]

The actuator can be constructed such that there is at least one piezoelectric-electrostriction material layer formed on the movement-generation sections with both sides located between electrode layers, however, it is preferred that this kind of piezoelectric-electrostriction material layer be layered having two or more layered layers. The amount of expansion and contraction of the piezoelectric-electrostriction material layer is proportional to the electric field intensity, however, by using the aforementioned layered form, the piezoelectric-electrostriction material layer becomes thin, so the necessary electric field intensity is obtainable at a low voltage, and thus it is possible to decrease the drive voltage. Also, by using the same drive voltage as in the case of single-layer construction, it is possible to obtain even greater expansion and contraction. The thickness of the piezoelectric-electrostriction material layer is not particularly limited

and can be suitably set according to various conditions such as drive voltage, required expansion and contraction, ease of manufacturing, and the like; however normally it is preferred to be approximately 5 to 50 μm. There is no particular upper limit to the number of layered piezoelectric-electrostriction material layers, and can be suitably set so that it is possible to obtain the target thickness for the movement-generation sections. A piezoelectric-electrostriction material layer is located further outside than the furthest outside electrode layer and serves as a cover.

[0022]

The slider 2 can be constructed of a material having relatively low electrical resistance, such as ceramic, for example, Al_2O_3-TiC, Mn-Zn ferrite, or the like. A magnetic core, coil or the like is installed on one side surface of the slider 2 by way of an insulation layer, to form the electromagnetic-conversion element 1.

[0023]

It is not shown in the figure, however, a wiring pattern for driving the actuator 4, or the wiring pattern that is connected to the electromagnetic-conversion element 1 is formed on the surface of the suspension as necessary. Moreover, it is possible to place an IC chip (read/write IC) for the head drive on the surface of the suspension 3. By installing a signal-processing IC on the suspension, it is possible to shorten the length of the wiring pattern that runs from the electromagnetic-conversion element to the signal-processing IC, so it is possible to decrease the induction component and increase the resonant frequency.

[0024]

The present invention is suitable in the case of using a single-body actuator having the construction shown in Fig. 8, however, besides this,

the invention could also be applied to cases in which various kinds of actuators having assembled construction that use a piezoelectric element, an actuator that utilizes electrostatic force, an actuator that utilizes electromagnetic force, or the like is used.

[0025]

The suspension 3 is typically constructed from a metallic material having elasticity such as stainless steel or the like, however, it could also be constructed from an insulating material such as resin, plastic or the like. On the other hand, constructing the wiring pattern such that the conductive wiring is covered by a resin or plastic covering, and attaching part of it to the surface of the suspension is normal. The method for forming a wiring pattern having this kind of construction is not particularly limited, however, it is possible to use a method in which a resin or plastic film is formed on the surface of the suspension 3 as an insulating film, and conductive wiring is formed on top of this, and then a resin or plastic film is further formed as a protective film; or a method may be used in which a wiring film made from a layered body having this kind of resin or plastic film and conductive wiring is attached to the suspension 3.

[0026]

In this invention, electrostatic damage to the electromagnetic-conversion element is prevented by grounding the slider in the magnetic-head-support mechanism having the construction described above. Grounding of the slider of this invention will be explained in detail below.

[0027]

In a first embodiment of the invention, the grounded area of the suspension is electrically connected to the slider by an electrical-connection member that can move and /or deform in the direction

that the slider is moved by the actuator.

[0028]

Fig. 1 shows an example of the construction of a first embodiment. Fig. 1 is a side view that shows the state of the slider 2 attached to the suspension 3 by way of the actuator 4. Adhesive 7a is used for both attaching the stationary section 43 of the actuator 4 to the suspension 3, and attaching the movable section 44 of the actuator 4 to the slider 2. The suspension 3 is made from an electrically conductive material such as metal, and is kept at ground potential. Therefore, here the suspension 3 itself becomes the aforementioned grounded area. The slider 2 and the suspension 3 are electrically connected by a highly flexible lead wire 8, and static electricity that is generated by the slider 2 flows to the suspension 3 via the lead wire 8. The electrical connection between the lead wire 8 and both the slider 2 and suspension 3 is done by using an electrically conductive adhesive 7b.

[0029]

Fig. 2 shows another example of the construction of a first embodiment. Fig. 2 is a plan view as seen from side of the suspension 3 that faces the disc medium and it shows the state of the slider 2 attached to the suspension 3 by way of the actuator 4. In Fig. 2, a grounding conductor 9 is formed on the surface of the suspension 3, and a grounding electrode 91, which is the aforementioned grounded area, is connected to one end of the conductor 9. The other end of the grounding conductor 9 is connected to an electrically conductive body (HDD frame, etc.) that is at ground potential. The grounding electrode 91 and the slider are electrically connected by a highly flexible lead wire 8, so the slider 2 is grounded. The electrically connecting the lead wire 8 to both the slider 2 and grounding electrode 91 is done by using an electrically conductive adhesive 7b. Reference number 52 in the figure is the wiring for the actuator drive, and it is attached to and located on the surface of the suspension 3. Also,

reference number 51 in the figure is the signal wiring that is electrically connected to the electromagnetic-conversion element, and it runs from the rear surface in the figure of the suspension 3 to the tip end of the suspension 3, and connects to the terminal-electrode group of the electromagnetic-conversion element located on the slider 2.

[0030]

In Fig. 1 and Fig. 2, a highly flexible lead wire 8 is used, so grounding of the slider 2 does not prevent movement of the actuator 4. Also, the location for connecting the lead wire 8 to the slider 2 can be selected relatively easily. With the construction shown in Fig. 2, the slider 2 can be grounded even when the suspension 3 is made from an insulating material.

[0031]

In a second embodiment of the invention, an electrically conductive area is formed on at least part of the actuator, and the grounded area of the suspension is electrically connected to the slider by way of this conductive area.

[0032]

Fig. 3 shows an example of the construction of the second embodiment. Fig. 3 is a side view that shows the state of the slider 2 attached to the suspension 3 by way of the actuator 4. The suspension 3 is made from an electrically conductive material such as metal, and is kept at ground potential. Also, a grounding conductor 9 is formed on the surface of the actuator 4 as the aforementioned conductive area such that it connects the stationary section 43 with the movable section 44. Moreover, an electrically conductive adhesive 7b is used for attaching the stationary section 43 of the actuator 4 to the suspension 3, and for attaching the movable section 44 of the actuator 4 to the slider 2, and this adhesive 7b covers one end and the other end of the aforementioned grounding

conductor 9.

[0033]

Depending on the type of actuator, it is possible to construct the entire actuator or the part just near the surface from an electrically conductive material. In this case, the entire actuator or the part just near the surface is used as the aforementioned electrically conductive area, and it possible to ground the slider.

[0034]

Fig. 4 shows another example of the construction of the second embodiment. In Fig. 4, the actuator 4 is the aforementioned layered-type piezoelectric actuator. As described above, in a layered-type piezoelectric actuator, each piezoelectric-electrostriction material layer is placed between a pair of electrode layers. In Fig. 4, one of the pair of electrode layers (the grounding conductor 9 in the figure) is used as the aforementioned electrically conductive area for grounding the slider 2. More specifically, both ends of the grounding conductor 9 are exposed to the side surface of the actuator 4, and by electrically connecting one end to the suspension 3 and connecting the other end to the slider 2 using an electrically conductive adhesive 7b, the slider is grounded. The other construction is the same as that shown in Fig. 3.

[0035]

In Fig. 3 and Fig. 4, when attaching the actuator 4 to both the suspension 3 and slider 2, electrically conductive adhesive is used instead of normal adhesive, and when manufacturing the actuator 4, the slider 2 can be grounded by just forming and exposing a grounding conductor 9. Therefore, grounding of the slider 2 does not obstruct at all the movement performance of the actuator 4. Also, only a small increase in the number of processes for grounding the slider is required.

[0036]

In Fig. 3 and Fig. 4, electrically conductive adhesive was used, however, in typical electrically conductive adhesive, electrically conductive material such as silver foil or carbon powder is dispersed in adhesive resin, so the adhesive properties are inferior when compared to normal adhesive. Therefore, the electrically conductive adhesive can be used together with normal adhesive when necessary.

[0037]

In a third embodiment of the invention, the wiring, which is electrically connected to the electromagnetic-conversion element, and the wiring pattern, which includes the grounding conductor that is electrically connected to the slider, extend from the surface of the suspension, over the actuator and to the slider. This wiring pattern can move and/or deform in the direction that the actuator moves the slider.

[0038]

Fig. 5 shows an example of the construction of this third embodiment. Fig. 5 is a plan view as seen from the surface of the suspension 3 that faces the disc medium, and it shows the state of the slider 2 attached to the suspension 3 by way of the actuator 4.

[0039]

In Fig. 5, there is a wiring pattern made from a flexible wiring substrate that includes the signal wiring that is electrically connected to the electromagnetic-conversion element of the slider 2. This wiring pattern comprises: attached wiring 5A that is attached to the surface of the suspension 3, and floating wiring 5B that goes over the tip end of the suspension 3 and is in a state of floating above the suspension 3. The reference number 52 in the figure is wiring for the actuator drive, and it is attached to the surface of the suspension 3.

[0040]

Of the wiring pattern comprising the attached wiring 5A and floating wiring 5B, first the attached wiring is formed from a flexible wiring substrate on the surface of the suspension 3 that faces the medium, then the tip-end second of the suspension 3 is removed, and part of the aforementioned attached wiring is formed as the wiring in the floating state. In the example shown in the figure, after forming a terminal-electrode group 94 beforehand consisting of four terminal electrodes on the tip-end section of the flexible wiring substrate, part of the tip-end section of the suspension is removed so that part near the terminal-electrode group 94 remains as a terminal-electrode plate 32. Also, the floating wiring 5B is curved or bent to the slider 2 side, and together with attaching the terminal-electrode plate 32 to the rear surface shown in the figure of the slider 2, the terminal-electrode group 94 is connected to the terminal-electrode group on the slider 2. However, it is not necessary to form a terminal-electrode plate 32, and construction is also possible in which the floating wiring 5B is connected directly to the terminal-electrode group on the slider 2. Removal of part of the suspension 3 can be performed by punching, wet etching or the like.

[0041]

In Fig. 5, the floating wiring 5B is formed such that it can be connected to the terminal-electrode group of the slider 2, and so that in that connected state it can move and/or deform in the direction that the actuator 4 moves the slider 2. Therefore, the floating wiring 5B does not obstruct the movement performance of the actuator 4.

[0042]

Signal wiring 51, which is electrically connected to the electromagnetic-conversion element, is added to the wiring pattern consisting of attached wiring 5A and floating wiring 5B, and it includes the grounding conductor 9. One end of this grounding conductor 9 is

connected to the grounding electrode 91 which is arranged in line with the terminal-electrode group 94 formed by the floating wiring 5B, and the other end is connected to a conductive body (HDD frame, etc.) that is at ground potential. The grounding electrode 91 is electrically connected to the slider 2 by electrically conductive adhesive, metal ball, or the like, so the slider 2 is grounded.

[0043]

In Fig. 5, the grounding electrode 91 on the floating wiring 5B is electrically connected to the surface of the electromagnetic-conversion element of the slider 2, however, in the case where a low-resistance ceramic such as A_2O_3–TiC is not exposed on this surface, it is possible to connect to a surface on which a low-resistance ceramic is exposed by changing the location of the grounding electrode 91 as shown in Fig. 6. Also, as shown in Fig. 7, by using construction in which the grounding terminal 91 on the floating wiring 5B and the slider 2 are connected by a lead wire 8, it is possible to relatively freely select the location for connecting to the slider 2.

[0044]

In the third embodiment, the slider 2 is grounded using flexible wiring such as the floating wiring 5B described above, so grounding of the slider 2 hardly obstructs the movement performance of the actuator 4 at all. Also, when grounding the slider 2, it is not necessary to change the construction of the actuator 4. Moreover, compared with other embodiments, the number of processes is less, which makes it suitable for automated production processes as well.

[0045]

In the third embodiment, construction can also be such that the attached wiring 5A is formed on the surface of the suspension 3 that does not face the medium, and the floating wiring 5B that is continuous with

this attached wiring 5A passes over the tip end of the suspension 3 to reach the slider 2.

[0046]

In the magnetic head of a fourth embodiment of the invention, a wiring pattern, which includes wiring that electrically connects to the electromagnetic-conversion element or optical module, and a grounding conductor that electrically connects to the slider, is formed such that it is attached to the surface of the suspension, and the tip-end of the suspension is curved or bent over the actuator toward the slider, and at least part of this tip end is such that it can move and/or deform in the direction that the actuator moves the slider. The magnetic head of this fourth embodiment can be made using a method similar to that used for making the magnetic head of the third embodiment. For example, in Fig. 5, which shows the third embodiment, the tip-end of the suspension 3 between the terminal-electrode plate 32 and the suspension 3 is completely removed, however, when making the magnetic head of this fourth embodiment, it is possible to the leave part with the wiring pattern attached without completely removing between the terminal-electrode plate 32 and the suspension 3. Also, this terminal-electrode plate can be such that the tip-end section of the suspension is curved or bent over the actuator so that it reaches the slider 2 in the same way as the terminal-electrode plate 32 shown in Fig. 5. In the case of this kind of construction, the tip-end section of the suspension can be curved or bent as described above, and its rigidity must be low enough that it can move and/or deform in the direction that the actuator moves the slider. The area where the rigidity is low can be formed by etching both sides of the tip-end section of the suspension after forming the attached wiring as described above, however, it is also possible to use a suspension that has been processed beforehand into a shape such that the rigidity of the tip-end section becomes low. In the fourth embodiment as well, similar to as in the third embodiment, it is not necessary to form a terminal-electrode plate 32.

[0047]

Above, of recording/reproduction heads, the magnetic head for a HDD was described, however, the invention can also be applied to an optical-disc apparatus. In a conventional optical-disc apparatus, an optical pickup is used that comprises at least an optical module having a lens. In this optical pickup, the lens is mechanically controlled so that the focal point corresponds to the recording surface of an optical disc. However, recently, near-field recording has been proposed as a method for significantly increasing the recording density of an optical disc [NIKKEI ELECTRONICS 1997.6.16 (no. 691), p. 99], and in this near-field recording, a floating-type head is used. This floating-type head uses a slider that is similar to that of a floating-type magnetic head, and built into this slider is a semi-spherical lens called SIL (solid immersion lens) and an optical module having a pre-focus lens. A floating-type head for near-field recording is also disclosed in US patent no. 5,497,359. In this kind of floating-type head, similar to an HDD magnetic head, as the recording density becomes higher, it becomes necessary to improve the tracking precision, so an actuator having minute movement is effective. Therefore, the present invention can also be applied to the recording/reproduction head (optical head) for this kind of optical-recording medium.

[0048]

In more general terms, the optical head to which the present invention can be applied has a slider that is similar to that of the aforementioned mentioned magnetic head, and an optical module is built into this slider, or that slider itself is constructed from an optical module. The optical module has at least a lens, and furthermore, when necessary, a lens actuator, magnetic field generation coil are built in. Besides the floating-type head for the aforementioned near-field recording, an optical head in which the slider moves the medium surface back and forth, or in other words, a

pseudo-contact-type or contact-type optical head can be given as an example of this kind of optical head. The case in which the invention is applied to an optical head can be easily understood by replacing electromagnetic-conversion element with optical module when reading the explanation above. This invention can also be applied to a pseudo-contact-type or contact-type magnetic head as well.

[0049]

In the specification of this invention, the scope of the recording/reproduction head includes a recording/reproduction head, recording-only head and reproduction-only head, and similarly, the scope recording/reproduction apparatus includes a recording/reproduction apparatus, recording-only apparatus and reproduction-only apparatus.. Also, the recording medium is not limited to a recordable medium, and a reproduction-only medium such as a reproduction-only optical disc is also included within its scope.

[0050]

[Effect of the Invention]

With the recording/reproduction-head-support mechanism of this invention, it is possible to ground the slider without obstructing the movement performance of the actuator, so it is capable of preventing electrostatic damage to the electromagnetic-conversion element or optical module without sacrificing their positioning precision.

WHAT IS CLAIMED IS:

1. A recording/reproduction-head-support mechanism comprising:

a slider, in which an electromagnetic-conversion element or optical module is installed, and a suspension; wherein

the slider is supported by the suspension by way of an actuator for moving the slider; and

a grounding area on the suspension is electrically connected to the

slider by an electrical-connection member that is capable of moving and/or deforming in the direction that the actuator moves the slider.

2. The recording/reproduction-head-support mechanism of claim 1 wherein the suspension is constructed from electrically conductive material, and the suspension itself is used as said grounding area.

3. The recording/reproduction-head-support mechanism of claim 1 wherein a grounding electrode is formed on the surface of the suspension as said grounding area.

4. A recording/reproduction-head-support mechanism comprising:

a slider, in which an electromagnetic-conversion element or optical module is installed, and a suspension; wherein

the slider is supported by the suspension by way of an actuator for moving the slider; and

a electrically conductive area is formed on at least part of the actuator, and a grounding area on the suspension is electrically connected to the slider by way of this electrically conductive area.

5. A recording/reproduction-head-support mechanism comprising:

a slider, in which an electromagnetic-conversion element or optical module is installed, and a suspension; wherein

the slider is supported by the suspension by way of an actuator for moving the slider; and

a wiring pattern, which includes wiring that electrically connects to the electromagnetic-conversion element or optical module, and a grounding conductor that electrically connects to the slider, is capable of moving and/or deforming in the direction that the actuator moves the slider, and extends from the surface of the suspension over the actuator to the slider.

6. A recording/reproduction-head-support mechanism comprising:

a slider, in which an electromagnetic-conversion element or optical module is installed, and a suspension; wherein

the slider is supported by the suspension by way of an actuator for moving the slider;

a wiring pattern, which includes wiring that electrically connects to the electromagnetic-conversion element or optical module, and a grounding conductor that electrically connects to the slider, adheres to and is formed on the surface of the suspension; and

the tip-end section of the suspension curves or bends over the actuator toward the slider, and at least part of said tip-end section is capable of moving and/or deforming in the direction that the actuator moves the slider.

7. A recording/reproduction apparatus comprising the recording/reproduction-head-support mechanism of any one of the claims 1 to 6.

ABSTRACT

A recording/reproduction-head-support mechanism of a magnetic-disc apparatus or optical-disc apparatus having an actuator for minute movement that prevents electrostatic damage of an electromagnetic-conversion element or optical module without obstructing the movement performance of the actuator.

A recording/reproduction-head-support mechanism comprising a slider, in which an electromagnetic-conversion element or optical module is installed, and a suspension; wherein the slider is supported by the suspension by way of an actuator for moving the slider; and a grounding area on the suspension is electrically connected to the slider by an electrical-connection member that is capable of moving and/or deforming in the direction that the actuator moves the slider.

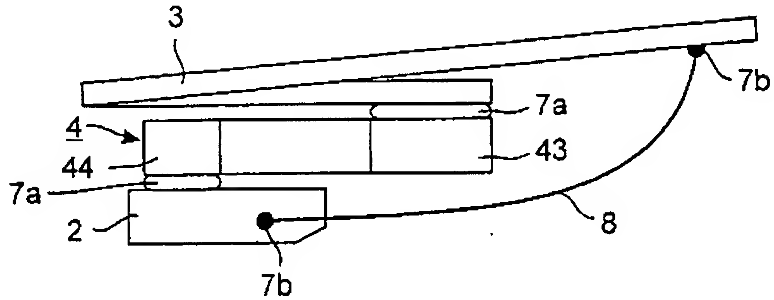
Drawings

[Explanation of Reference Numbers]

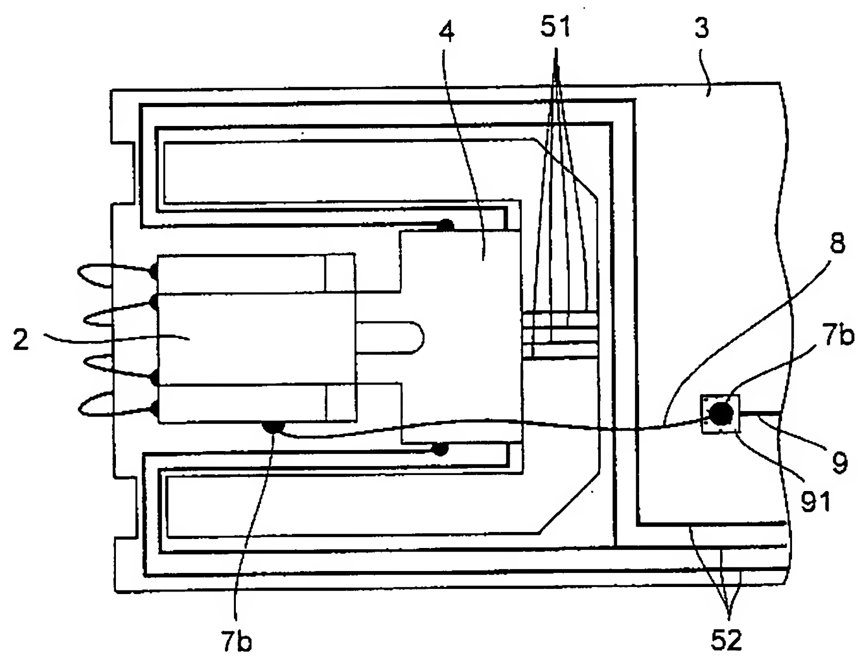
1 Electromagnetic-conversion element
2 Slider
3 Suspension
3a Gimbal section
32 Terminal-electrode plate
4 Actuator
41 Movement-generation section
43 Stationary section
44 Movable section
5A Attached wiring
5B Floating wiring
51 Signal wiring
52 Actuator-drive wiring
7a Adhesive
7b Electrically conductive adhesive
9 Grounding conductor
91 Grounding electrode
94 Terminal-electrode group

【Document】 Figures

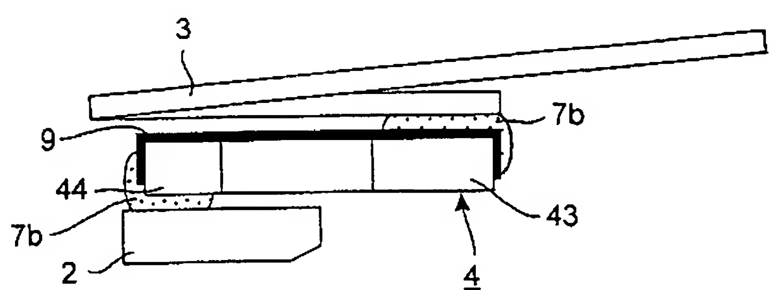
【Fig.1】



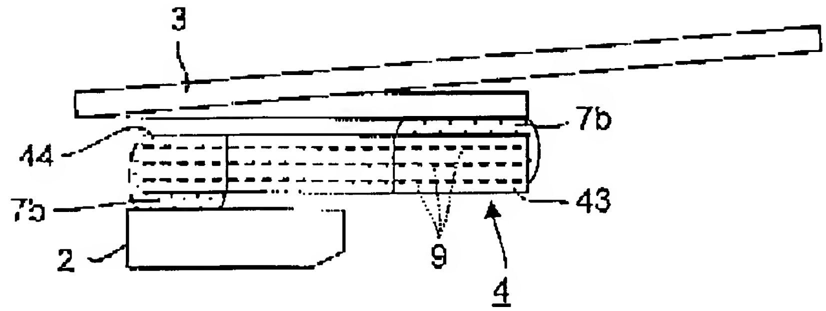
【Fig.2】



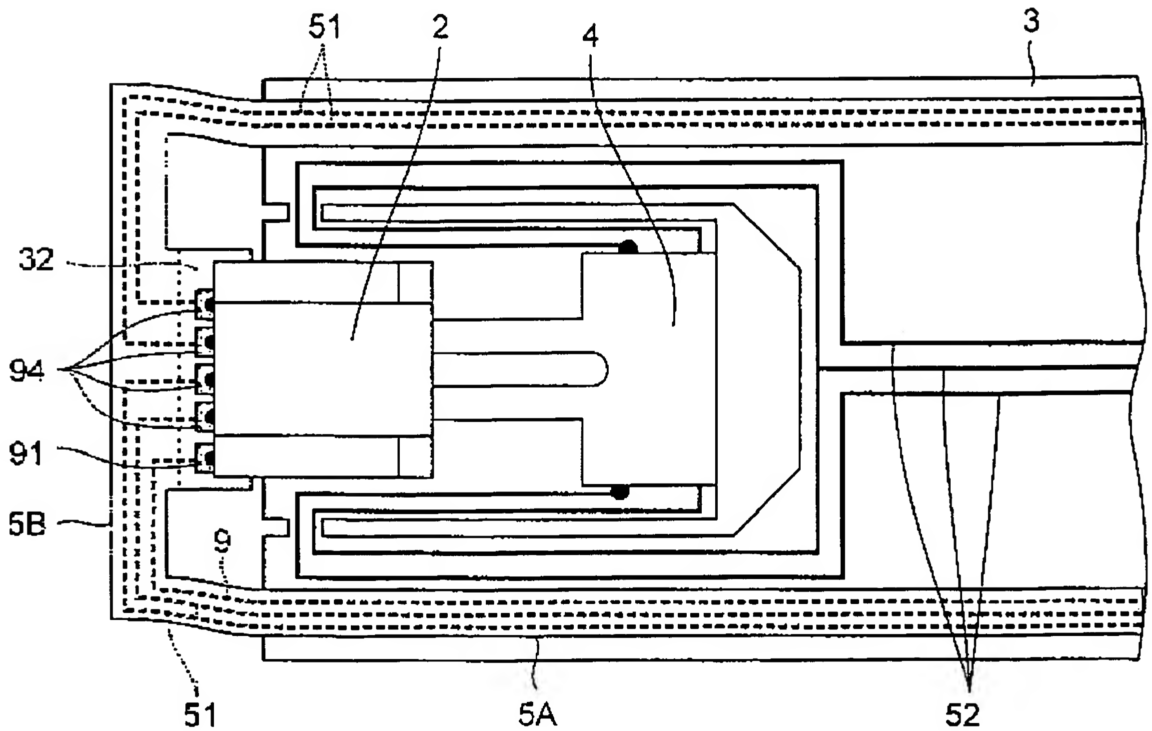
【Fig.3】



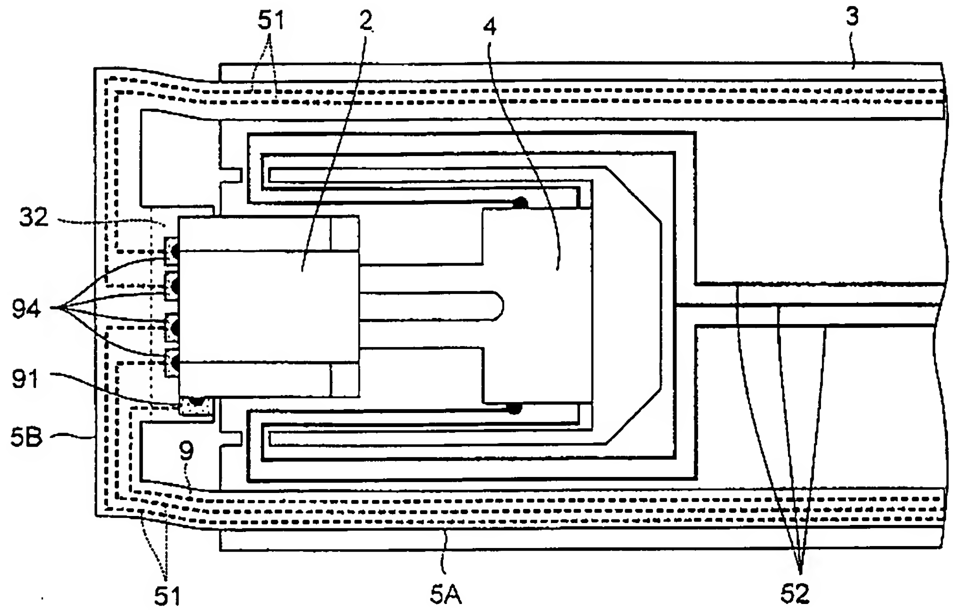
【Fig.4】



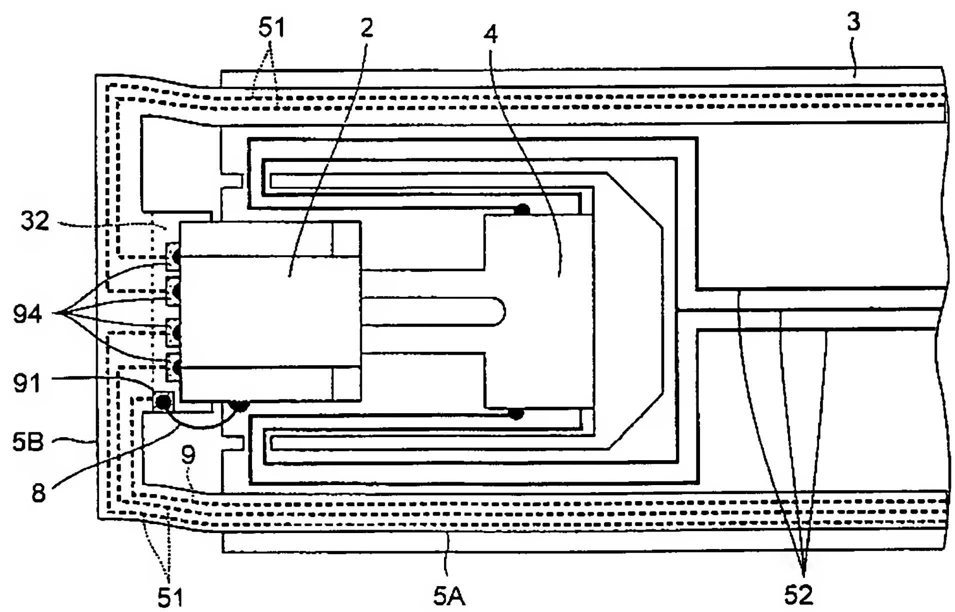
【Fig.5】



[Fig.6]



[Fig.7]



〔Fig.8〕